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RAPTOR PREDATION PROBLEMS AND SOLUTIONS

Robert E. Kenward
Institute of Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset BH20 5AS U.K.

Large raptors have probably been seen as a nuisance since the dawn of stock farming. Accusations are sometimes unjustified, in that most large raptors are opportunistic scavengers. For example, more than one careful analysis has shown that lambs at nests of eagles (*Aquila*) were almost all scavenged. Nevertheless, other studies have documented predation by eagles on live lambs (Murphy 1977), by Peregrine Falcons (*Falco peregrinus*) on trained pigeons near lofts and during races (Treleaven 1977), by hawks (*Accipiter*) on poultry, and by eagles (*Haliaeetus*) or Ospreys (*Pandion haliaetus*) at fish farms (Draulans 1987).

Those preserving game have long seen raptors as competitors for a harvestable resource or even as a threat to the survival of game stocks. However, early field studies either showed raptors taking few game (Craighead and Craighead 1956, Brüll 1964) or that raptors and other predators were taking mainly the diseased or socially displaced individuals (Errington 1946, Jenkins et al. 1963). Early population models suggested that predators which depressed prey populations were themselves liable to become extinct (Gause 1934).

Nevertheless, more recent models have shown that predators can depress numbers of a particular prey and still persist, either because alternative prey are available or because prey numbers increase through breeding before all the predators die (Hassell 1978, Kenward and Marcström 1988, Sinclair 1990). Evidence has now accumulated that game bird populations can be depressed by raptors locally near nests (Eng and Gullion 1962), temporarily during irruptions (Keith and Rusch 1988), in heavily managed landscapes (Kenward et al. 1981) and even on moorland (Redpath and Thirgood 1997). In Europe, renewed concern about raptor predation on livestock, poultry, pigeons and game (Kalchreuter 1981) also extends to rare tetraonids and sea birds on nature reserves.

Solving Predation Problems

Although there is now evidence that raptor predation can cause problems for wardens of domestic animals, game and other wildlife, the difficulties tend to be local or temporary. There is no excuse for a return to widespread persecution of raptors, because there are now many other ways of avoiding predation problems.

Exclusion can be effective for reducing predation on livestock during a short vulnerable period, for example, by penning sheep during lambing to protect against eagles (Murphy 1977). In Sweden, Ring-necked Pheasants (*Phasianus colchicus*) are sometimes caught and penned in midwinter, to ensure the survival of breeding stock through the late winter period when Northern Goshawk (*Accipiter gentilis*) predation on wild pheasants tends to be most intense. Penning protects against nonraptor predation, too, but tends to be expensive. A variety of other exclusion techniques are available for use at fish farms (Draulans 1987).

Landscaping is extremely important, for example, by improving cover. Agricultural intensification tends to remove cover, thus presumably increasing prey vulnerability and reducing or concentrating sources of winter food. This may increase prey activity, thus again increasing vulnerability, and cause gatherings which attract raptors, especially if game is fed artificially to replace scarce natural foods. Cover can often be improved both at feed sites and on approaches to them (Mikkelsen 1984). Nearby perches for raptors might also be removed. There is scope for much more research on how game depend on cover and natural foods, in order to maximize benefits with minimal loss of farmed land. Breeding success of game can be doubled by leaving headlands unsprayed (Potts 1986); perhaps similar minor modifications can improve survival in winter. Serious predation on game may often reflect not only recovery in raptor populations from persecution and pollution, but also increase in prey vulnerability through changes in land management.

Deterrence of birds from crops and airfields is now well-developed (Murton 1971, Blokpoel 1976). Scaring techniques include the use of distress calls, moving figures to simulate humans with guns and even kites which simulate raptors. Mirrors and shell crackers have been tried against raptors, but without clear evidence of success. Similarly, although it has been suggested that territoriality might reduce predation pressure by deterring conspecifics, this did not prevent goshawks accumulating where many pheasants were released (Kenward 1977). However, following early work on chemical deterrence in raptors (Brett et al. 1976) and new evidence that some prey have developed powerful toxins to deter predators (Dumbacher et al. 1992), there is scope for more study of whether spray-on aversives can be used to make racing pigeons or released game unpalatable.

Distraction of predators by an abundance of alternative prey reduces mammal predation on tetraonid broods (Marcström et al. 1988). However, promoting alternative prey may also be counterproductive. For example, an abundance of rabbits (*Oryctolagus cuniculus*) encouraged goshawks to accumulate and prey heavily on wild pheasants, possibly because these were a preferred prey (Kenward 1986). More study is needed.

Preemption can be used by hunters to compete with raptors by harvesting game before raptor predation becomes most intense. For example, if there is a predation peak after vegetation die-back reduces cover in winter, shooting earlier is likely to harvest more game.

Compensation can be used to offset losses at farms or fish hatcheries, but schemes are hard to operate efficiently without excessive claims. An indirect form of compensation, by paying a reward for local nests which fledge young, may be more effective, and can also be used where farm or forest activities unwittingly destroy nests. Rewards encourage local interest in birds and can help status surveys. With imagination, tourism could also compensate for frequent predation at small sites, such as fish farms.

Relocation can reduce local predation from goshawks, if they are released more than 30 km from capture sites (Marcström and Kenward 1981). Spring nets set on kills seem to be the ideal capture technique, because they are selective of the hawks taking poultry or game, and can only be applied effectively when there really is a problem, whereas cage traps baited with pigeons catch other hawks too (Kenward et al. 1983). However, relocating trapped hawks is most practical for uncommon species, especially if they can be released in areas where populations have been depressed. If a species is common, and predation problems so widespread that there is no convenient release area, relocation may be an inefficient use of resources.

Removal is the alternative to relocation. It must be considered, because conservation can suffer if serious predation problems are ignored. Respect may be lost for conservation laws, and birds be killed anyway, unselectively. Unfortunately, techniques preferable for selective management (i.e., live-trapping before shooting, and certainly no poisoning) are the reverse of those which best evade detection if used illegally: traps are evidence for all to see, whereas shooting is hard to detect and poisoning can be done with great discretion. Raptors are now poisoned quite frequently in Britain (Cadbury 1990). Although strict protection can be an important tool for preserving threatened raptor populations, if treated as an ideology, it can also promote damaging conflicts. In the long term, habitat loss is probably the biggest threat to both raptors and game, so game conservers and raptor enthusiasts should be allies in habitat preservation. Conservation does not benefit if conflicts divert attention and resources, while agriculture and other developments cause devastating land-use changes.

Nevertheless, removal of raptors should probably be licensed only (1) when there is no other economically acceptable technique and nothing works except compensation or relocation, but they waste resources because the species is already at "carrying capacity." (2) When a sustainable yield has been estimated for the raptor population such as the case where radiotagging showed that a goshawk population in Sweden was already yielding 15% of its juveniles, which were being shot (legally) at farms. Nevertheless, first-year survival was much better than in ringing estimates, and the population was stable with many nonbreeding adults (Kenward and Karlbom 1991). Moreover, there was no breeding at all by first-year hawks, although this occurs commonly where goshawks are below carrying capacity or adult mortality is increased. Data from such areas predicted that Swedish hawks could have maintained a stable population by compensatory reduction in breeding age if the killing increased to 35% of juveniles, and could have yielded about 50% of juveniles if shooting compensated for starvation, the other main cause of death. (3) When a removal method has been designed to militate against any adverse effect. Ideally, it should involve live-trapping, so that nontarget species can be released unharmed and target species need not be killed. It should also be selective of individuals creating the problem, and become unproductive when there is little predation. Spring nets set on kills are ideal. (4) When alternatives to killing removed birds have been adequately assessed. Small numbers of live birds may be useful for research, aviculture or educational purposes. Supplying such birds to falconers, against payment of a suitable fee, might benefit conservation more than obliging falconers to pay for birds from domestic breeding schemes. Even when birds are killed, samples can be used for pesticide analyses or other forms of environmental monitoring. Solving predation problems by removing raptors is very much a last resort. It requires raptor enthusiasts to acknowledge that healthy raptor populations, like game birds, are a renewable resource. By the same token, those with problems should remember that raptor predation can be beneficial too, as when nest boxes are used to increase the local density of Barn Owls (*Tyto alba*) thereby reducing damage by rats in Malaysian oil palm plantations (J.E. Duckett, unpubl. data).

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